

# FDI and trade: complements *and* substitutes

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October 2005

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## Abstract

This paper presents a non-monotonic relationship between foreign direct investment and trade based on the idea that, although FDI eliminates trade costs on the final good, the investing firm has to bear increased trade costs on an intermediate good.

*Keywords:* Foreign Direct Investment, Trade, Firm Location

*JEL classification:* F23, L12,R30

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This paper had the support of the Research Unit on Complexity in Economics (UECE)

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## 1. Introduction

The theory of location of firms that engage in foreign direct investment (FDI) presents two opposing views on the relationship between FDI and trade. On the one hand, horizontal FDI displaces trade: instead of exporting, the firm sets up a subsidiary in the foreign country, trading off lower trade costs against higher fixed costs (see, among others, HORSTMANN and MARKUSEN, 1992). FDI is "tariff-jumping" and is positively related with trade costs. On the other hand, vertical FDI splits the production process into segments that are relatively intensive in different factors of production. Each segment is located in the country that is abundant in the required factor (see HELPMAN, 1984). Since each plant must export its output as an intermediate good to other plants, vertical FDI complements trade and is eased by low trade costs.

These two simple patterns of relation between trade, FDI and trade costs are in contrast with empirical studies (see for instance PAIN and WAKELIN, 1998) that show that the relationship is complex. In this paper, a non-monotonic relationship is modeled, based on the idea, borrowed from BRAINARD (1993), of two vertically-linked firms with different degrees of divisibility. It is assumed that the upstream firm is indivisible and located in the home country. When the downstream firm invests abroad, it suppresses the trade costs on the exports of the final product, but it must bear additional trade costs on the input that has to be imported from the home country. This generates the possibility of a non-monotonic pattern.

A simple numerical example of this non-monotonic pattern was presented in PONTES (2004). In this note, we attempt to generalize the relationship following

the framework developed by NEARY (2002).

## 2. The model

We assume a spatial economy composed of two countries Home ( $H$ ) and Foreign ( $F$ ). There are two vertically-linked firms, upstream (firm  $U$ ) and downstream (firm  $D$ ), that are both located in country  $H$ . Firm  $U$  exhibits significant economies of scale that lead to the indivisibility of its production, so that it is forced to supply the foreign demand only through exports. Its pricing behavior is not analyzed, so that the price of the intermediate good  $w$  is parametric. Firm  $D$  uses  $\alpha \in (0, 1)$  units of this intermediate good to produce one unit of a consumer good.

Firm  $D$  has three different options for supplying the consumers in the foreign market: refrain from supplying  $F$  (we label this strategy as "0"); supply  $F$  through exports (strategy "1"); or supply  $F$  through a subsidiary (strategy "2"), resulting in a fixed cost  $G$ .

It is further assumed that the unit transport costs of the intermediate good and the final product vary in proportion. For the sake of simplicity, they will be assumed to be equal to  $t$ . Firm  $D$  transports the input and delivers the final product to the consumers.

The profits made by Firm  $D$  in the foreign market are given by:

$$\pi_0 = 0 \tag{1}$$

$$\hat{\pi}_1(p, t) = (p - \alpha w - t) f(p) \tag{2}$$

$$\hat{\pi}_2(p, t, G) = (p - \alpha w - \alpha t) f(p) - G \tag{3}$$

where  $p$  is the delivered price in country  $F$  and  $f(p)$  is the aggregate demand func-

tion in this market.  $f(p)$  is well-behaved in the usual sense (i.e. it is continuous, decreasing and the total revenue function is concave).

It is assumed that, for each value of  $t$ , the firm selects a profit-maximizing price. It can easily be concluded that this price is an increasing function of  $t$ , in both cases "1" and "2". We define

$$\pi_1(t) = \max_p \widehat{\pi}_1(p, t) \quad (4)$$

$$\pi_2(t, G) = \max_p \widehat{\pi}_2(p, t, G) \quad (5)$$

It is clear that 4 is a continuous function and that

$$\begin{aligned} \pi_1(0) &> 0 \\ \lim_{t \rightarrow \infty} \pi_1(t) &< 0 \end{aligned}$$

Function 4 is decreasing, since, using the envelope theorem

$$\frac{d\pi_1}{dt} = \frac{\partial \pi_1}{\partial t} = -f(p) < 0$$

Hence, there is a unique threshold  $\tilde{t}$ , such that

$$\pi_1(t) \geq 0 \text{ iff } t \leq \tilde{t} \quad (6)$$

The choice between strategies "2" and "0" can be analyzed by means of the implicit function

$$\pi_2(t, G) = 0 \quad (7)$$

Using the implicit function theorem on 3 and 5, it can be concluded that there

is everywhere a continuous function  $G(t)$  whose first and second derivatives are

$$\frac{dG}{dt} = -\alpha f(p) < 0 \quad (8)$$

$$\frac{d^2G}{dt^2} = -\alpha f'(p) \frac{dp}{dt} > 0 \quad (9)$$

so that the function is decreasing and convex. It can easily be concluded that  $G(0)$  is positive and finite, and that  $\lim_{t \rightarrow \infty} \pi_2(t, G) < 0$ , so that  $G(t)$  intercepts the  $t$  axis. Moreover, the value  $\tilde{G}$  such that  $\pi_2(\tilde{t}, \tilde{G}) = 0$  is positive since the operating profit of strategy "2" is positive for  $t = \tilde{t}$ . From 2, 3, 4 and 6, we have

$$p - \alpha w - \alpha \tilde{t} > \pi_1(\tilde{t}) = 0$$

The choice between strategies "1" and "2" can be examined through the implicit function

$$H(t, G) = 0 \Leftrightarrow \pi_1(t) - \pi_2(t, G) = 0$$

where  $\pi_1(t)$  and  $\pi_2(G, t)$  are given by 2, 4 and 3, 5. Using the implicit function theorem, it can be concluded that there is a continuous function  $G(t)$  that passes through the origin in space  $(t, G)$  and through the point  $(\tilde{t}, \tilde{G})$ . This function has the following first and second derivatives:

$$\frac{dG}{dt} = -\frac{H_t}{H_G} = (1 - \alpha) f(p) > 0 \quad (10)$$

$$\frac{d^2G}{dt^2} = (1 - \alpha) f'(p) \frac{dp}{dt} < 0 \quad (11)$$

so that  $G(t)$  is increasing and concave.

Pulling together the results obtained so far (namely in 6, 8, 9, 10 and 11), we

can plot the regions in space  $(G, t)$  where each strategy of serving the consumers in the foreign market is most profitable for the downstream firm.

(Insert here Figure 1)

In Figure 1, FDI is feasible for some value of trade costs provided that the fixed costs are lower than  $\tilde{G}$ . Let us suppose that this is the case and trade costs are so high that the firm does not find it profitable to supply the foreign market (strategy "0" dominates). If trade costs decrease, there is first a transition  $(0) \longrightarrow (2)$ : it becomes profitable to set up a subsidiary in the foreign market and to import the necessary intermediate goods. FDI and trade (in intermediate goods) are complements in relation to trade costs. However, if trade costs are further reduced, we have a second transition  $(2) \longrightarrow (1)$ : trade costs are so low that it pays to supply the foreign market through exports of the final good rather than by FDI. Trade is enhanced since the amount of trade in consumer goods exceeds the trade in intermediate goods. FDI and trade behave as substitutes in relation to trade costs.

### 3. Conclusion

It has been possible to conclude that the relationship between FDI and trade costs is non-monotonic. This relationship is positive for high values of trade costs, where FDI and trade behave as complements. But it becomes negative for low values of trade costs, with trade and FDI then behaving as substitutes.

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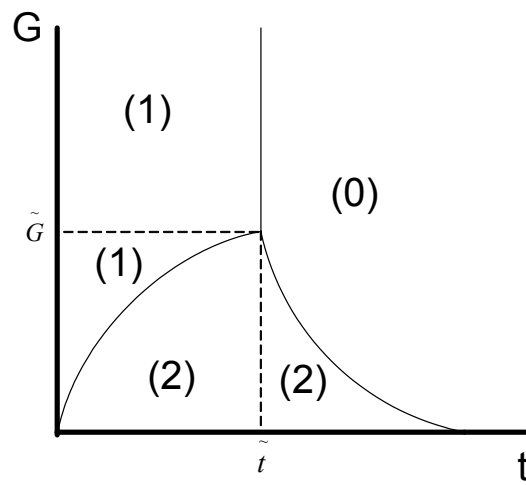


Fig.1: Location of the multinational firm in space  $(t, G)$

Figure 1: